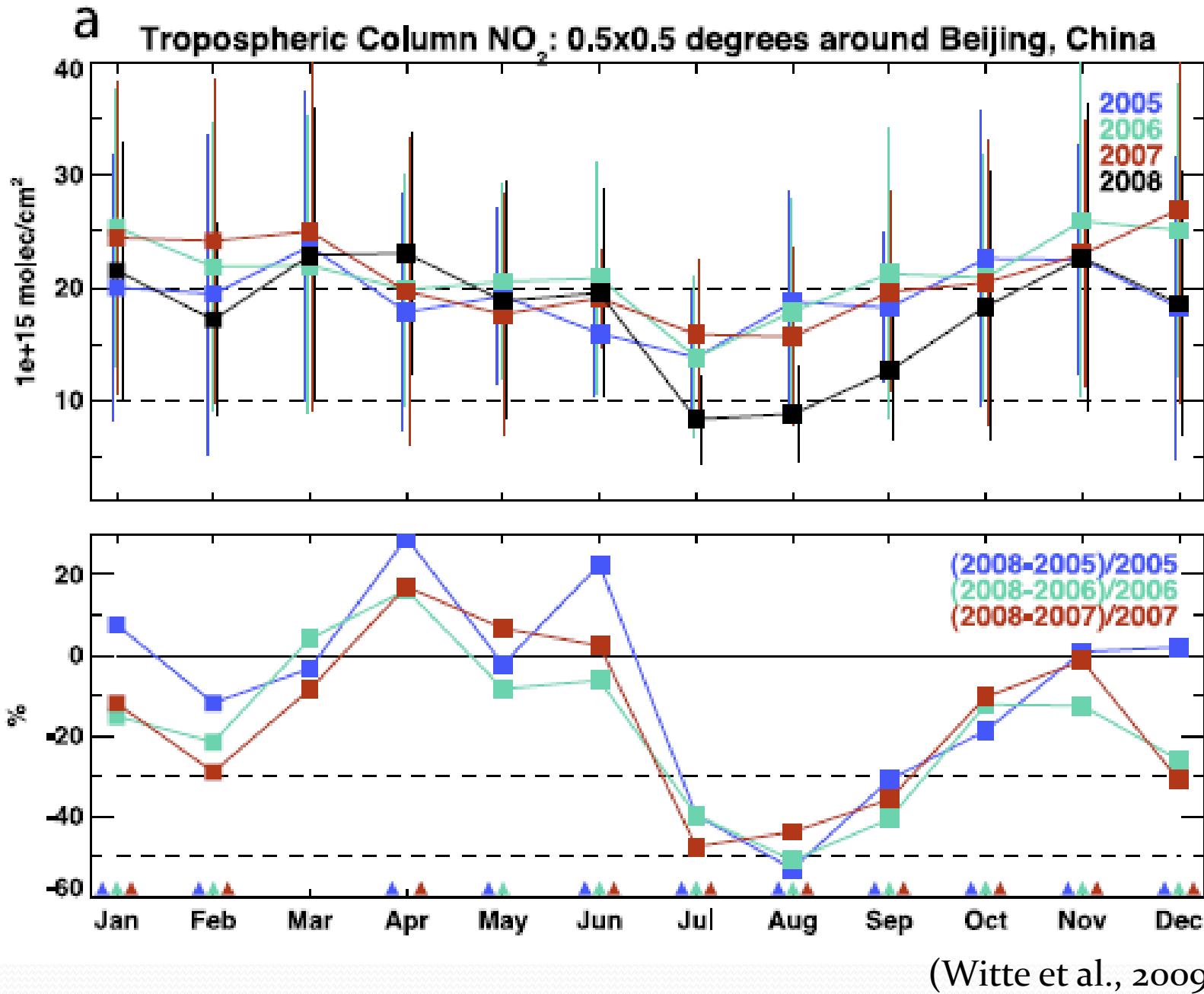


OMI-derived NO_x Emission Reduction and its Effects on Ozone during the 2008 Olympic Games

Qing Yang, Yuhang Wang,
Chun Zhao, and Zhen Liu



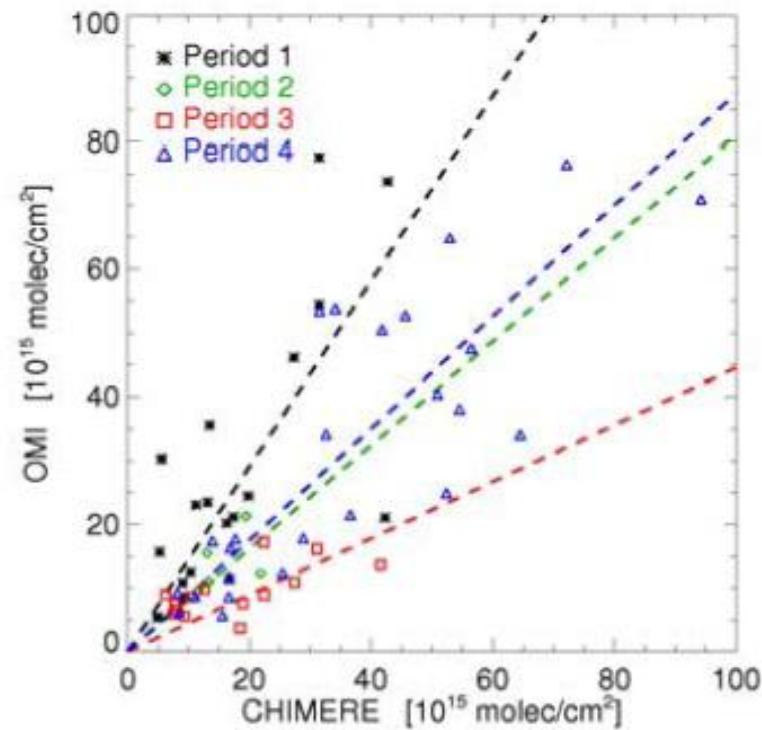
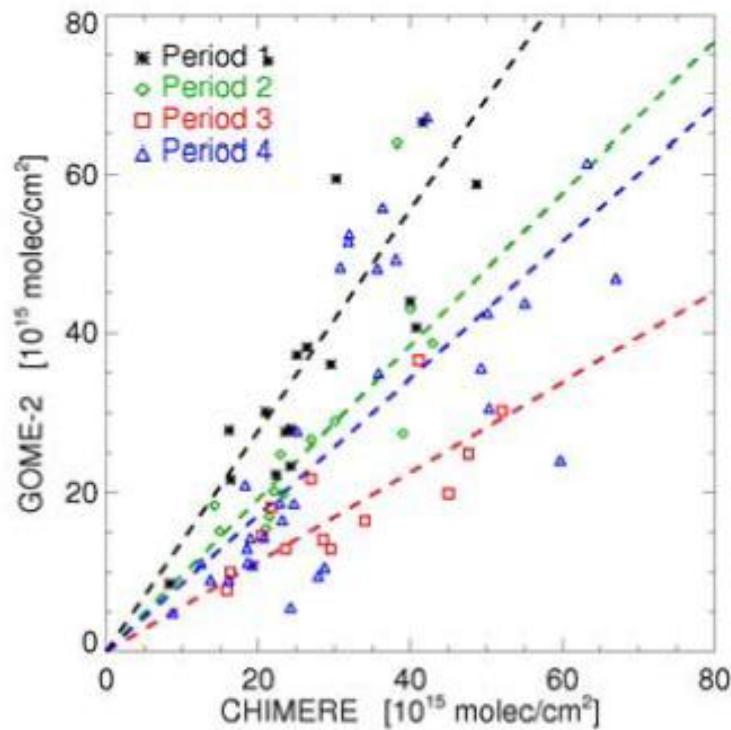
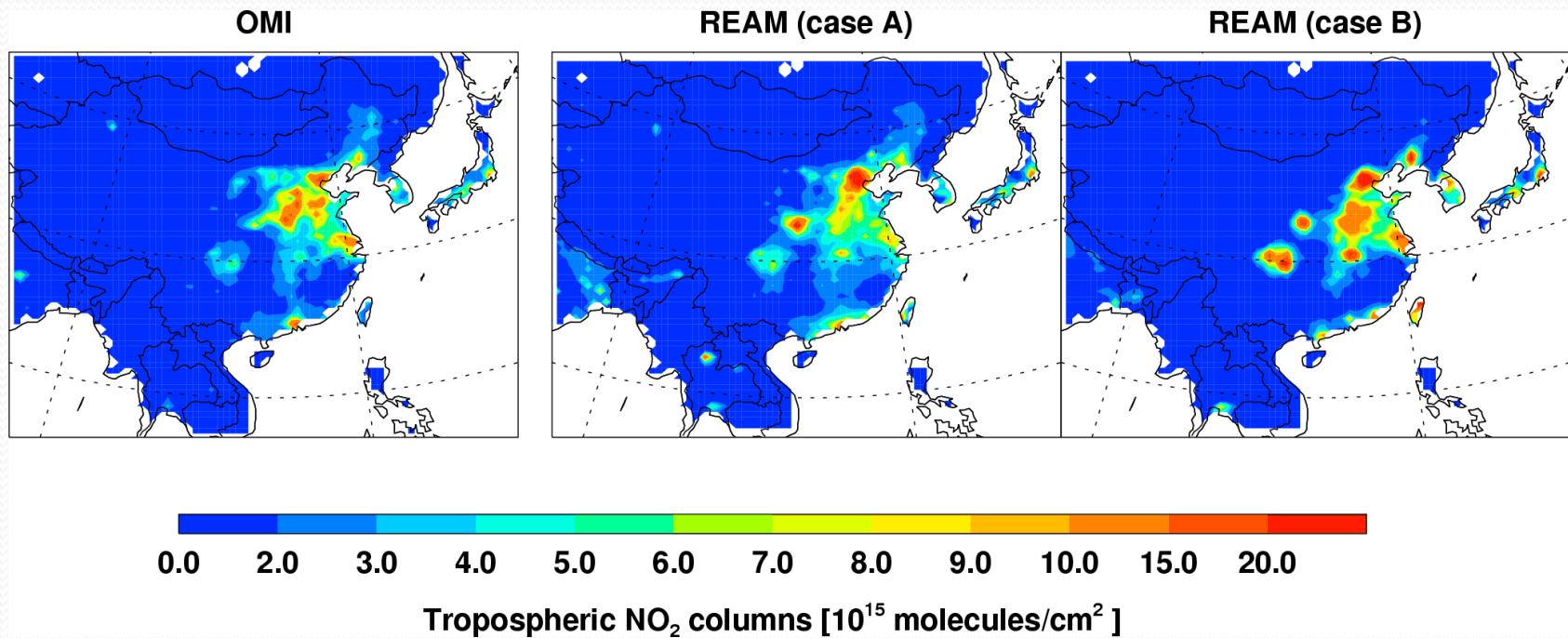


Table 2. Overview of the Results of the Comparison Between CHIMERE and GOME-2 and OMI for Each Period for Beijing

Period	GOME-2			OMI		
	Days With Data	Weighted Correlation	Scaled Concentration Reduction r	Days With Data	Weighted Correlation	Scaled Concentration Reduction r
2 May–30 June	17	0.67	0	19	0.70	0
1 July–7 Aug	13	0.76	31%	6	0.55	44%
8 Aug–17 Sep	13	0.82	59%	14	0.72	69%
18 Sep–30 Nov	34	0.60	38%	26	0.76	40%

(Mijling et al., 2009)

Tropospheric NO₂ columns



- Model simulated NO₂ columns do not have the same distributions as the observations
- Inverse modeling: Adjusting model emissions to match observations
- Develop a new daily assimilated inverse modeling approach

Inverse modeling

OMI NO₂ columns

- ✓ NRT data from KNMI/NASA [*Boersma et al., 2007*] and STD data from NASA (GES-DISC) [*Bucsela et al., 2006*]
- ✓ Cloud fraction <30%

$$E_t = \frac{E_{NO_x}^{MODEL}}{NO_2^{MODEL}} \cdot NO_2^{OMI}$$

$$\ln E_{apost} = \frac{\ln E_t (\ln \varepsilon_a)^2 + \ln E_a (\ln \varepsilon_t)^2}{(\ln \varepsilon_a)^2 + (\ln \varepsilon_t)^2}$$

$$(\ln \varepsilon_{apost})^{-2} = (\ln \varepsilon_a)^{-2} + (\ln \varepsilon_t)^{-2}$$

REAM NO₂ column/NO_x emissions

- ✓ 23 levels to 10 hpa, 70x70 km²
- ✓ WRF meteorological fields
- ✓ Fossil fuel combustion NO_x [Streets 2006 (case A) and POET 2000 (case B)]
- ✓ Lightning and soil NO_x [*Choi et al., 2008*]
- ✓ No biomass burning NO_x [~2%, *Wang et al. ,2007*]

A priori Error

- ✓ ~60% for surface emissions
- ✓ Fossil fuel combustion (~50%)
- ✓ Soil (300%) [*Wang et al, 2007*]

OMI top-down Error

- ✓ ~50% for top-down emissions
 - ✓ 40% for retrieval NO₂ columns
 - ✓ 30% for model error

E_{apost} : “a posteriori”
 E_a : “a priori”
 E_t : “top-down” } Emissions

Assimilated inverse modeling

$$E_t = \frac{E_{NO_x}^{MODEL}}{NO_2^{MODEL}} \cdot NO_2^{OMI}$$



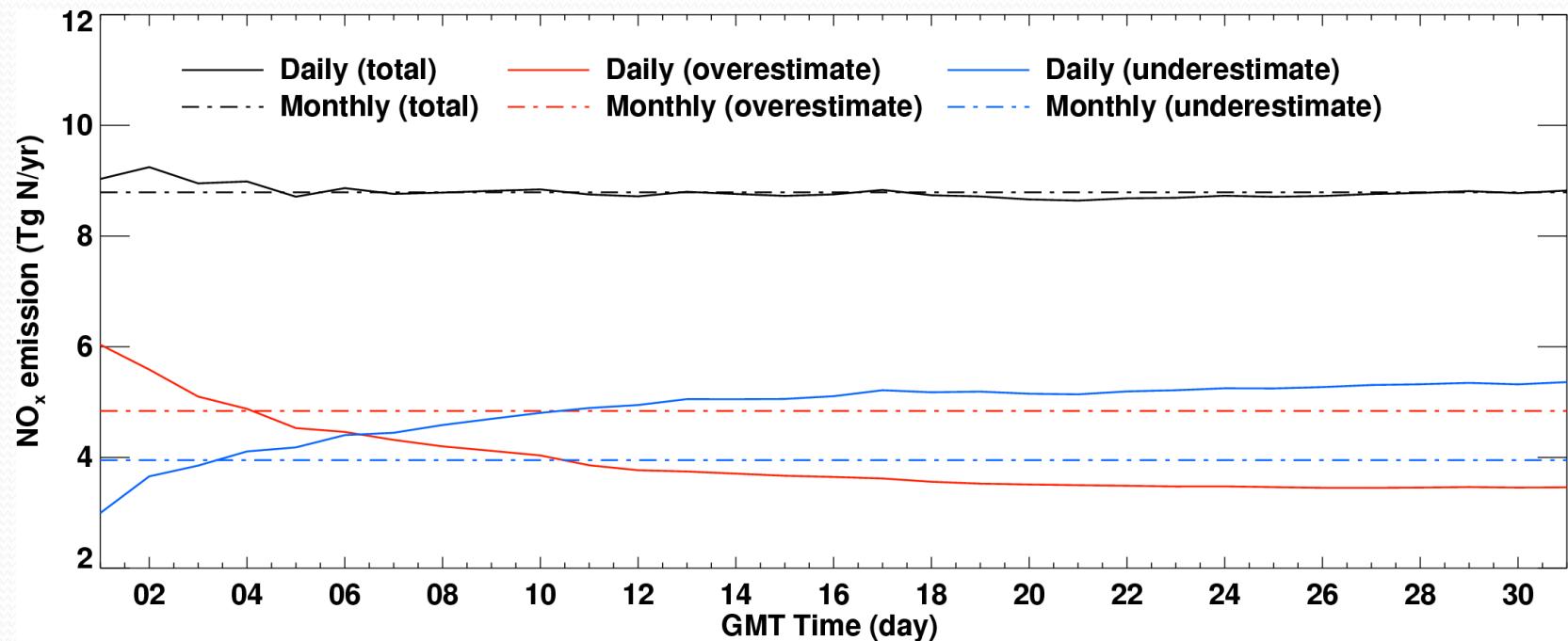
$$\ln E_{apost} = \frac{\ln E_t (\ln \varepsilon_a)^2 + \ln E_a (\ln \varepsilon_t)^2}{(\ln \varepsilon_a)^2 + (\ln \varepsilon_t)^2}$$

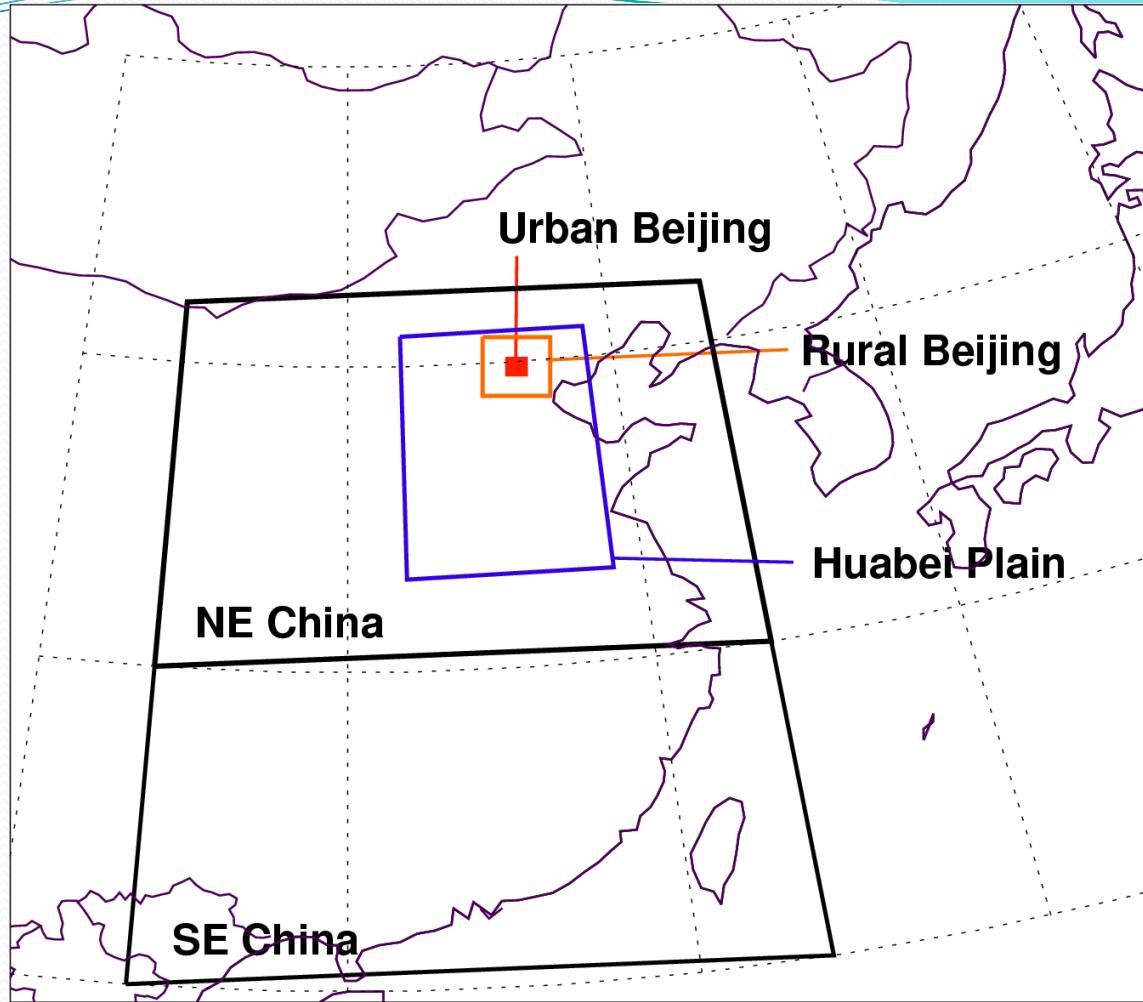
$$(\ln \varepsilon_{apost})^{-2} = (\ln \varepsilon_a)^{-2} + (\ln \varepsilon_t)^{-2}$$

	Monthly-mean	Assimilated daily
OMI-NO ₂		OMI pass time
MODEL-NO ₂		
E _a	Monthly mean	E _{apost} from last day
E _t		Daily updated at OMI pass time
E _{apost}		
ε_a	~60%	ε_{apost} from last day
ε_t	~50%	~50%
ε_{apost}	~36%	Daily updated at OMI pass time

(Zhao and Wang, GRL, 2009)

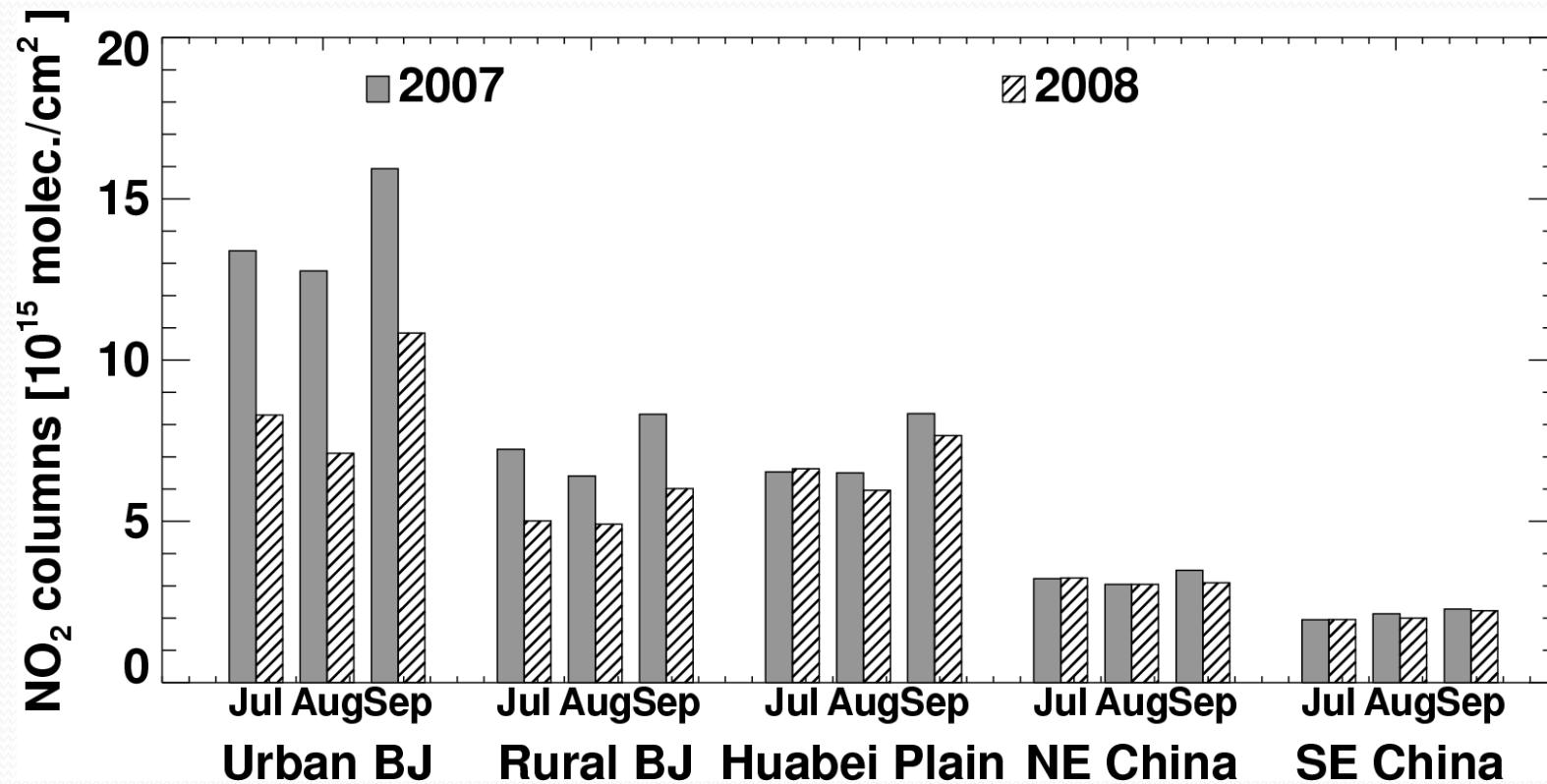
Daily assimilation inversion improves emission estimates





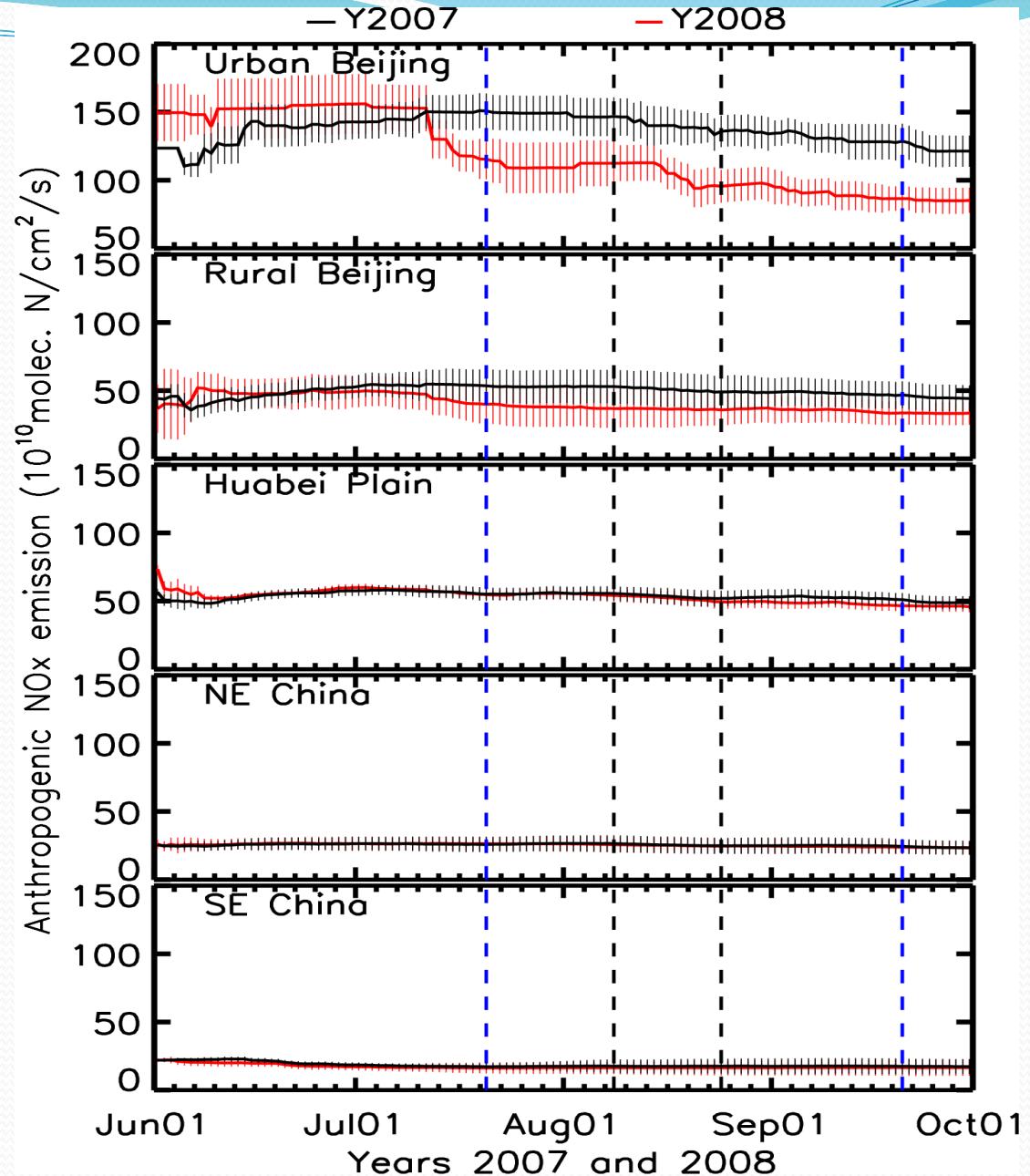
We divide East China into different regions and investigate the difference between 2007 and 2008

Over Beijing, large tropospheric NO₂ column decreases were found

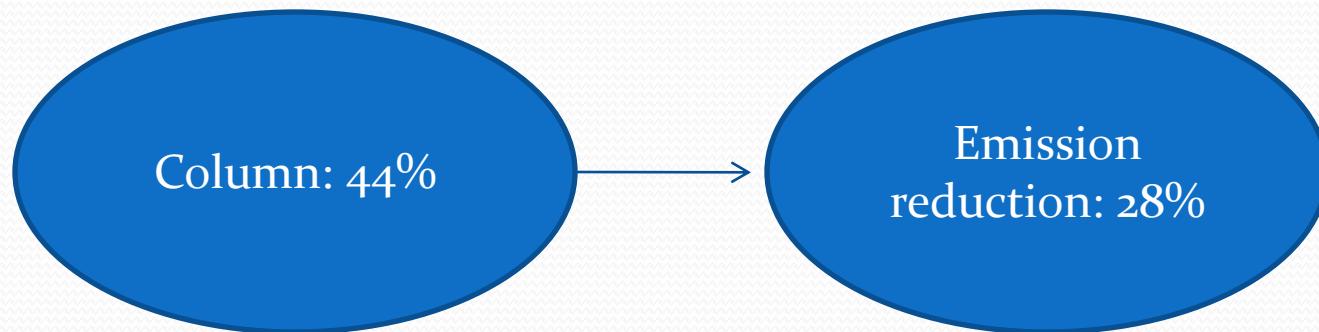


Emission reduction estimates

(Yang et al., to be submitted)



Emission reduction estimate



- Chemical feedback: OH
- Meteorology changes between 2007 and 2008

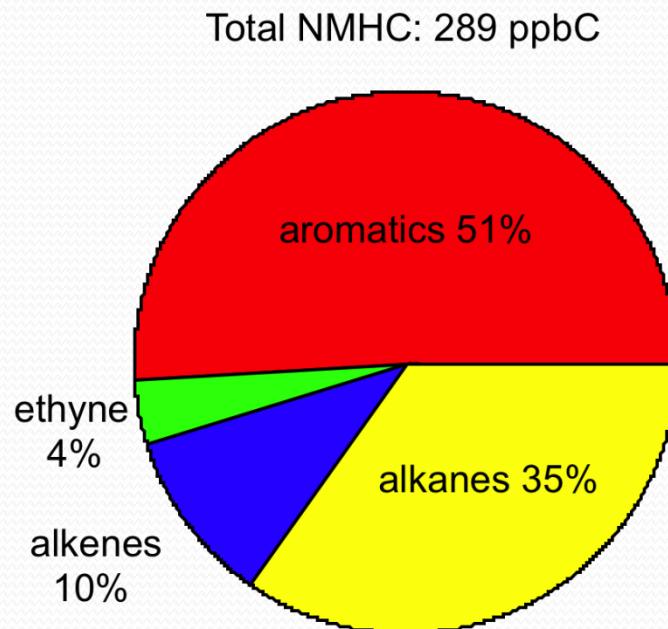
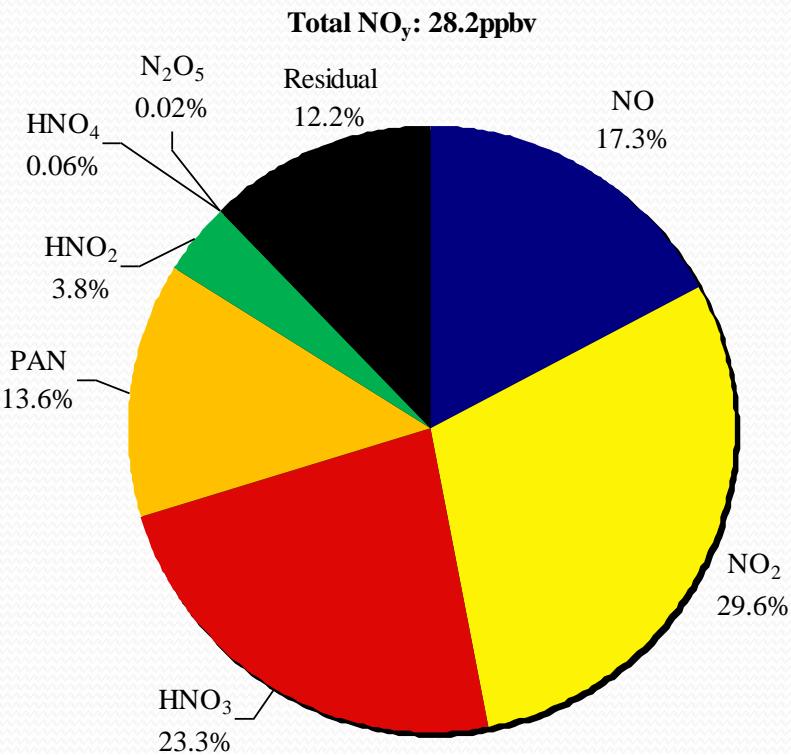
Effectiveness of emission control

- NOx reduction
- VOC reduction: Scaled to NOx
- NOx and VOC reductions

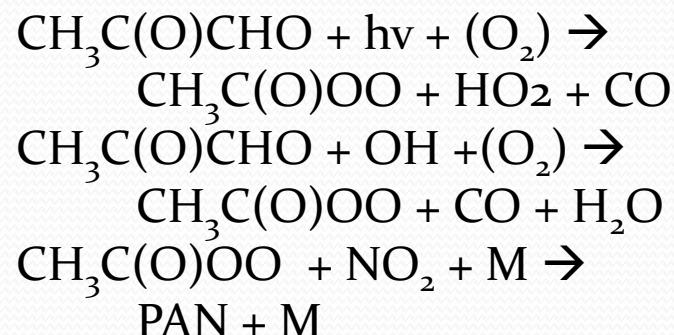
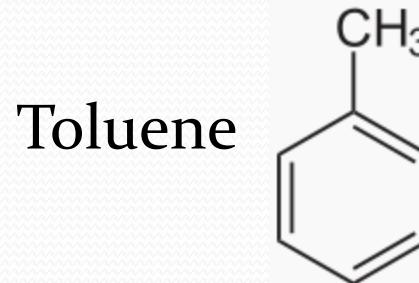
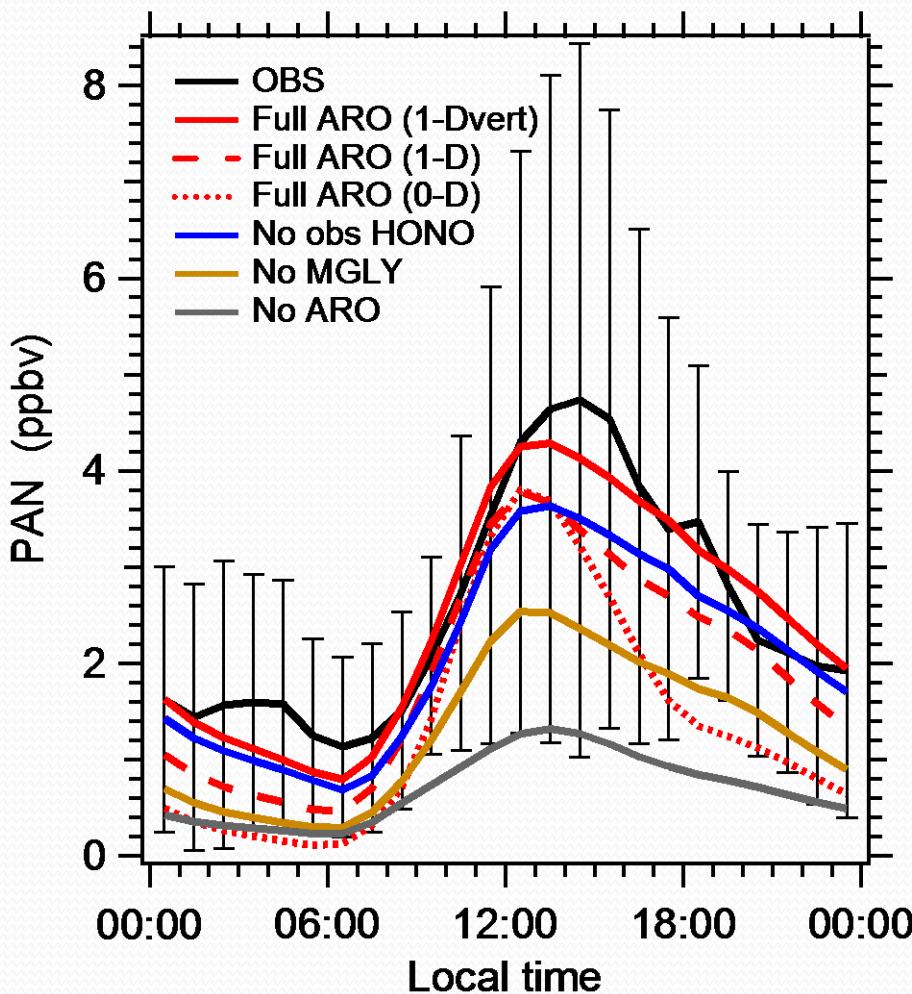
Urban photochemistry in Beijing



In situ observations



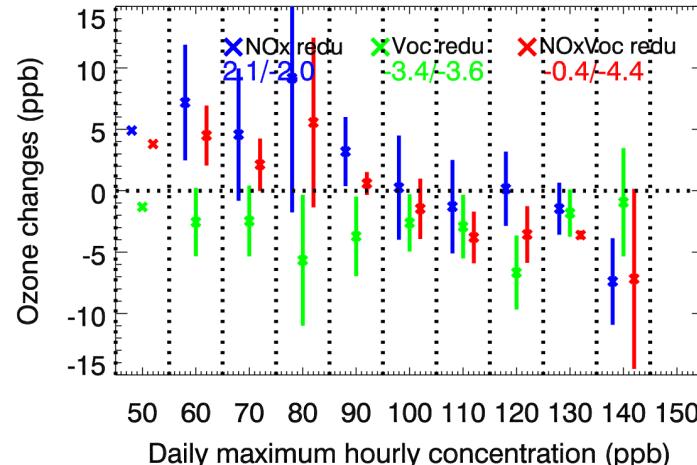
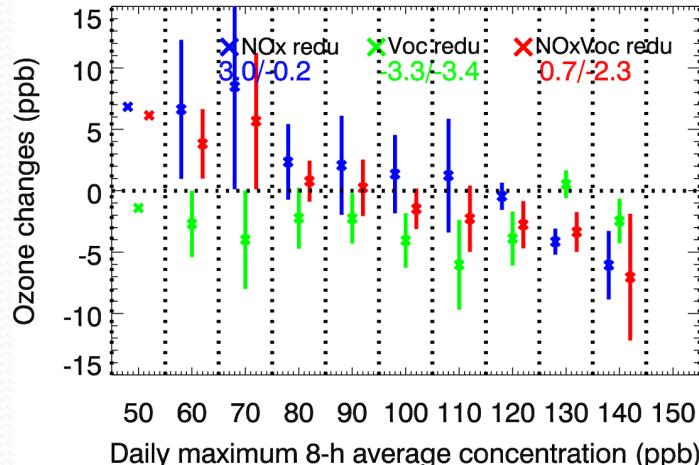
Methylglyoxal from aromatics



(Liu et al., ES&T, 2010)

The effects are relative small relative to emission changes

With Streets 2006 VOC inventory



With scaled Streets 2006 VOC inventory

